IMAGE ACQUISITION TIMING SYSTEM AND METHOD

Background of the Invention

Optical sources and sensors are included in a variety of optical imaging systems. In a typical optical imaging system, an optical source including one or more LEDs or other emitters illuminates a target, such as an imaging surface or navigation surface. The sensor detects reflected, scattered or transmitted light from the illuminated target. In an optical imaging system used for navigation, outputs from the sensor are processed to extract position, velocity, acceleration, or other motion parameters of the optical imaging system relative to the target. In other applications, the output from the sensor is processed to characterize features of the illuminated target.

Figure 1 shows an exemplary control signal C for timing image acquisitions in a conventional optical imaging system (shown in Figure 2). In this example, the optical source within the optical imaging system is turned "on" by a falling edge transition in the control signal C and turned "off" by a rising edge transition in the control signal. Image acquisitions are triggered to occur at the same falling edge transition that turns the optical source "on".

When the optical source is "off", the target is not illuminated and the sensor does not receive light. During this "off" time the sensor will typically discharge due to current leakage (referred to as "dark current") inherent within the devices used to implement the sensor, which can affect the sensitivity or transfer characteristics of the sensor.

In optical imaging systems where the sensor includes one or more CMOS detectors, photodiodes or other transducers, non-uniform discharge between these devices can result in non-uniform image sensitivity or artifacts in the images acquired when the sensor initially receives light from re-illumination of the target. In optical imaging systems

used for navigation, dark current discharge of the sensor can result in cursor jump upon re-illumination of the target.

One approach avoids the dark current discharge of the sensor by illuminating the target continuously, so that the sensor continuously receives light. This approach has the obvious disadvantage of high power consumption, as constant illumination of the target translates to the optical source being on continuously. In a portable optical imaging system, such as an optical mouse for a computer, this high power consumption can lead to unacceptably low battery life. Accordingly, there is a need for an alternative way to accommodate for dark current discharge in the sensor within an optical imaging system.

Summary of the Invention

A system and method for timing image acquisitions according to the embodiments of the present invention provide an optical charge pulse to a sensor within an optical imaging system prior to image acquisitions by the optical imaging system. This optical charge pulse compensates for dark current discharge in the sensor.

Brief Description of the Drawings

Figure 1 shows an exemplary control signal for timing image acquisitions in a conventional optical imaging system.

Figure 2 shows a conventional optical imaging system.

Figure 3 shows exemplary control signals associated with a system and method for timing image acquisitions according to the embodiments of the present invention.

Figure 4 shows the system for timing image acquisitions according to embodiments of the present invention.

Figures 5-6 show the method for timing image acquisitions according to alternative embodiments of the present invention.

Detailed Description of the Embodiments

Figure 3 shows exemplary control signals C_1, C_2 associated with a system 30 (shown in Figure 4) and method 40 (shown in Figures 5-6) for timing image acquisitions in an optical imaging system 20, according to embodiments of the present invention. The optical imaging system 20 is shown including an optical source 2 and a sensor 6. The optical source 2 typically comprises a light emitting diode (LED) or other emitter, or an array of one or more LEDs or other emitters. The sensor 6 typically comprises one or more CMOS detectors, photodiodes or other transducers that convert light to electrical signals that can be processed by an image processor 8 within the optical imaging system 20.

The control signal C_1 is typical of the control signals within an optical imaging system 20. While the control signal C_1 is typically available within the optical imaging system 20, the control signal C_1 is alternatively generated, for example, using a signal source. The control signal C_1 has a first transition 1 (shown as a rising edge in Figure 3) that turns the optical source 2 "off" and a second transition 3 (shown as a falling edge) that turns the optical source 2 "on". This second transition 3 that turns the optical source 2 "off" triggers the optical source 2 to illuminate a target 4, such as an imaging surface or a navigation surface.

A second control signal C_2 has a transition 5, such as a falling edge, that triggers image acquisitions by the sensor 6 and image processor 8 when the target 4 is illuminated. This transition 5 within the control signal C_2 follows the transition 3 of the control signal C_1 and is delayed by a delay interval T. The portion of the control signal C_2 within the

delay interval T establishes an optical charge pulse P that is sufficient to compensate for dark current discharge of the sensor 6 within the optical imaging system 20.

Figure 4 shows the system 30 for timing image acquisitions according to embodiments of the present invention. In one example, the control signal C_2 is generated in response to the control signal C_1. Alternatively, the control signals C_1, C_2 are independently generated. A source controller 32 within the system 30 provides the control signal C_1 to the optical source 2, which is turned "on" or "off" according to the designated transitions 1, 3 within the control signal C_1.

The source controller 32 provides an "on" transition (in this example a falling edge) to the optical source 2, which turns the optical source 2 "on" for a time interval T_{ON}. When "on", the optical source 2 illuminates the target 4. At the end of the time interval T_{ON}, the source controller 32 provides an "off" transition (in this example a rising edge) to the optical source 2, which turns the optical source "off" for a time interval T_{OFF}. When "off", the optical source 2 is in a low power consumption state and does not illuminate the target 4.

A delay block 34 within the system 30 is coupled between the source controller 32 and the image processor 8 that is coupled to the sensor 6. The delay block 34, including a delay stage 36 and a logic stage 38, generates the control signal C_2 in response to the control signal C_1, which is also applied to the delay block 34. The control signal C_2 provides the transition 5, which triggers the image processor 8. In response to this trigger, which in this example is a falling edge, light from the illumination of the target 4 is intercepted by the sensor 6 and processed by the image processor 8, resulting in the acquisition of one or more images by the optical imaging system 20.

While falling edges are shown providing the trigger for turning the optical source 2 "on" and providing the trigger for images acquired in the above example, other types of transitions are alternatively used to provide these triggers. Based on the type of the transitions, the delay block 34 appropriately processes the transitions 1, 3 provided in the control signal C_1 to provide the optical charge pulse P. With the transition provided in this example, the delay block 34 has a logic stage 38 that includes an OR logic element to provide the optical charge pulse P. The optical charge pulse P has sufficient amplitude and/or width T to compensate for the effects of dark current discharge in the sensor 6 by turning the optical source 2 "on" prior to the triggering of image acquisitions by the transition 5 in the control signal C_2. While the optical charge pulse P is shown as a rectangular pulse, the optical charge pulse P alternatively has any of a variety of shapes that are suitable to compensate for the effects of dark current discharge of the sensor 6.

Alternative embodiments of the present invention are directed toward a method 40 for timing image acquisitions. The method 40 shown in Figure 5 includes triggering the optical source 2 to illuminate the target 4 (step 42). This step 42 typically includes steps 42a-42c as shown in Figure 6. Step 42a includes detecting an "off" transition, provided from step 48 in which the optical source 2 is turned "off" after image acquisition. In this example, the "off" transition is the rising edge within the control signal C_1. In step 42b a first delay t1 that starts at the "off" transition detected in step 42a is imposed. In step 42c, a trigger is generated at the end of the delay t1. This trigger is the transition 3 within the signal C_1 that turns the optical source 2 "on", triggering the optical source 2 to illuminate the target in step 42.

The method 40 for timing image acquisitions then includes imposing the delay interval T, starting when the optical source 2 is triggered to illuminate the target 4 (step

44), and triggering image acquisition at the end of the delay interval T (step 46). The optical source 2 is turned "off" in step 48 after the image acquisition. Typically, these steps 42-48 are repeated periodically, wherein the rate at which the steps are repeated is determined according to the application in which the optical imaging system 20 is used.

While the embodiments of the present invention have been illustrated in detail, it should be apparent that modifications and adaptations to these embodiments may occur to one skilled in the art without departing from the scope of the present invention as set forth in the following claims.